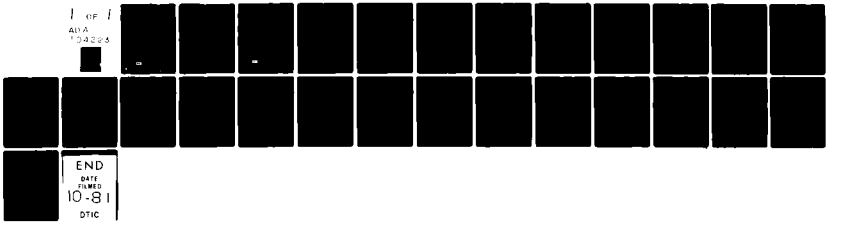
AD-A104 223 CENTER FOR NAVAL ANALYSES ALEXANDRIA VA INST OF NAVAL--ETC F/G 15/7
WESTERN EUROPEAN AND NATO NAVIES, 1980.(U)
AUG 81 S S ROBERTS
UNCLASSIFIED CNA-PP-316 NL



PROFESSIONAL PAPER 316 / August 1981

WESTERN EUROPEAN AND NATO NAVIES, 1980

Stephen S. Roberts

CENTER FOR NAVAL ANALYSES

The ideas expressed in this paper are those of the author.
The paper does not necessarily represent the views of either
the Center for Naval Analyses or the Department of Defense.

PROFESSIONAL PAPER 316 Aug[redacted]81

WESTERN EUROPEAN AND NATO NAVIES, 1980.

Stephen S. Roberts

Institute of Naval Studies

CENTER FOR NAVAL ANALYSES

2000 North Beauregard Street, Alexandria, Virginia 22311

WESTERN EUROPEAN AND NATO NAVIES, 1980

The 14 navies of Western Europe and NATO (excluding the U.S. Navy) include some of the largest and best equipped fleets in the world, excluding those of the two superpowers. Most of them have significant ongoing procurement programs, some of them in the context of long-term naval program-laws. Their naval armaments industries are now equipping not only their own fleets but also those of most of the world's smaller navies. While none of them is large enough to rival the navy of either superpower, the non-U.S. NATO navies together constitute a major Western resource that could tip the balance in a naval conflict with the Warsaw Pact.

Navies are extremely complicated organizations, but their most characteristic feature, and the one used most often to judge their strength, is their combatant ships. When looking at new developments in the forces of these navies, notably new ship procurement programs, the initial impression is one of radical change. Indeed, major advances in capabilities are being made, due to advances in technology and to the tendency of successive ship designs to increase in size. However in most of these navies one thing has tended to remain relatively constant -- the overall force structure. The mere fact that most ships last well over 20 years means that changes in force structure will be a gradual process, and this tendency has been reinforced by factors such as

limited financial resources, conservatism in naval leaderships, and, in the case of NATO navies, a relative continuity in missions during the period NATO has been in existence. In this initial survey of the 14 Western European and NATO navies, we will focus on identifying changes and continuities in their combatant ship force structures during the last 30 years. This will enable us both to determine the role that ships now under construction will assume in the fleets and also to suggest with some confidence what new procurement efforts are likely to be undertaken in the future.

For purposes of comparison, ships have been grouped in the following categories: carriers, cruisers, destroyers, large frigates (which over time have increased in size within the general range of 1600 to 4200 tons full load), light frigates (1000 to 1600 tons), patrol escorts (800 to 1000 tons), large patrol craft (400 to 800 tons), fast attack craft (armed with anti-ship missiles or torpedoes), submarines, minesweepers (here limited to wooden-hulled ships over 290 tons full load), minelayers, and major amphibious ships (LSD and LST). Reclassifications of ships among combatant categories (notably from destroyers to frigates) have for the most part been ignored. Ships are counted as in the inventory from commissioning until they are deleted from the list or unambiguously relegated to auxiliary or subsidiary service. The survey is conducted in geographical order from the north west-

ward around Europe to the Mediterranean. Canada is also included since it is a NATO country.

The Swedish navy is the one navy of the 14 that is not associated either directly or indirectly with NATO. Its primary mission is deterrence or disruption of an invasion of Swedish territory, the main threat being from the east. Sweden, which now has only two destroyers in commission, has gone farther than the other Nordic countries in renouncing large ships in favor of fast attack craft and submarines. The number of these latter two types has not increased since 1960, however, and, in fact, the submarine force has declined since 1974 from its previous average of 22 units to 14, despite the introduction of three Nacken-class submarines in 1979-80. The near-term future of this submarine force appears assured by plans to modernize some of the oldest boats and by the order just given for the first unit of the new A-17 class. The fast attack craft force, which averaged around 40 units from around 1956 to 1975, will probably stabilize at 35 units after completion of the Jagaren class. In light of the cancellation of the M-70 minesweeper program, Sweden's minesweeping force is likely to decline. The naval minelayer force, which will soon consist of three modern ships, is backed up by some small Coast Artillery minelayers.

The Norwegian navy is responsible for the defense of the long Norwegian coast against attack by nearby Soviet sea and air forces and for operations on two vital sea routes -- the approaches to

the Baltic and Barents Seas. She allowed her destroyer force to disappear in the 1960s but renewed her frigate force by building five Dealey-class ships. A decision will have to be made soon on their replacement. She has augmented both her submarine and fast attack forces since the 1950s. Eight new small submarines have just been ordered in Germany to replace some of the existing 15 boats, and the Hauk class is the latest of several classes that have kept the fast attack force at a strength of around 46 units since around 1967. The minelaying force is led by two modern ships. Norway has retained her minesweeping force (now 10 MSC) intact, but has not updated it, and its future is not clear. The Norwegian air force operates about seven P-3B maritime patrol aircraft.

The Danish navy is concerned primarily with defense of its territory and operations in the Baltic approaches. Over the years its inventory of large frigates has dropped from 5 to 2 (which recently completed a mid-life overhaul), backed up by 3 to 4 patrol escorts and light frigates (the new Nils Juel class is now replacing the Triton class). The submarine force has doubled from 3 to 6 units, and plans are being made to replace some older submarines with German Type-210 units. The fast attack force has remained constant at around 16 units, ten of which today are of the new Willemoes class. As in Norway and Sweden, the minelayer force of seven units is reasonably up to date, but the small force of eight coastal minesweepers has been unchanged since the 1950s.

The navy of the Federal Republic of Germany has the mission of coastal defense and Baltic operations, but has also assumed another mission: cooperation in sea-control operations by larger ships in the North Sea. (This mission gained importance in 1980 when West Germany lifted a self-imposed restriction on naval operations north of 61° north.) West Germany has had 17 destroyers and large frigates since the early 1960s, but 10 will have to be replaced soon. To do this West Germany is now building six Bremen-class frigates and considering construction of two more. The German fast attack force has been at or above its current level of 40 boats since the early 1960s, and 10 Type-143A vessels are now building to replace the 10 oldest units. (The U.S. PHM class was originally programmed for this purpose but was dropped due to cost.) The submarine force of 25 boats is to be maintained by construction of the Type-210 submarine. The 18 coastal minesweepers still in service were built in 1958-60 but have all been updated, 12 by conversion to minehunters and 6 by conversion to control ships for "Troika" drone minesweepers. Unlike her neighbors to the north, West Germany has not maintained a naval minelaying force. The West German navy has two squadrons of F-104 fighter-bombers, which are to be replaced by Tornados, and one squadron of Atlantic maritime patrol aircraft, whose weapons and sensors are to be updated under a major new program.

The force structure of the Royal Netherlands Navy has changed very little over the last 30 years, except for the elimination of

a light carrier, but the missions of the ships have changed. Plans now are for the Netherlands to provide in the Atlantic and the Channel three escort groups (each with a leader, six frigates and an underway replenishment ship) and to operate in the North Sea a group of four smaller escorts and an offensive submarine force. She is also to operate mine countermeasure forces off her coast and in the Channel. Thanks to the Kortenaer frigate program and the modernization of the Van Speijk class, her force of destroyers and large frigates, which consisted of 18 ships in 1951, will soon consist of 18 modern frigates. The submarine force, which has consistently contained around six units, is being updated by construction of two Walrus-class units. The Alkmaar minehunters program should help stop the decline of the Dutch minesweeping force, which fell from 52 to 21 MSO and MSC in the 1970s. The ships that are needed for the fleet's missions but have not yet been ordered are one escort group leader to supplement the two Tromp-class missile destroyers and replacements for the existing smaller escorts, which date from 1954. Plans are being made to build a SAM variant of the Kortenaer-class to serve as leader and four 2500-ton M-class frigates for North Sea duty. The Dutch recently decided to buy 13 P-3C maritime patrol aircraft to replace 15 Neptunes. They also have seven Atlantics.

The Belgian navy owned two frigates in the early 1950s and operated some large steel minesweepers as escorts until 1969, but the commissioning of four Weilingen-class frigates in 1978 marks

her most effective participation to date in the mission of helping to protect shipping in the Channel. The rest of the Belgian navy has been a minesweeping force, which declined along with those of other NATO navies but which is to be renewed by construction of 10 tripartite minehunters in the 1980s.

The British Royal navy, once the world's largest fleet, is still the most important non-superpower navy. However, two decisions taken during the 1960s have profoundly altered its missions and operational behavior: the decision not to build a new-generation aircraft carrier and the decision to withdraw from east of Suez. The full effect of the first decision was finally felt in 1979 when Britain's last attack carrier, Ark Royal, was retired without relief. In partial compensation, however, RAF squadrons of Buccaneers and Phantoms (eventually to be replaced by Tornados) were dedicated to maritime operations around the British Isles. The effect of the second decision has been that, even though Britain occasionally sends task groups to operate overseas, nearly all her forces are committed to NATO to operate in European waters (the eastern Atlantic and the Channel) in case of war.

When looking at the force structure of the Royal navy since 1951, one finds a pronounced decline in nearly all categories of ships. This, however, is due in part to the fact that the British navy was practically the only European fleet to emerge from World War II with the makings of a large reserve fleet. By looking carefully at the figures, however, one can discern some trends and

continuities. The decline in the larger classes is indisputable: even the large destroyers of the postwar Devonshire class are beginning to disappear, and only three new ships larger than destroyers, the V/STOL and helicopter carriers of the Invincible class, have been provided for. (It should be noted, however, that Britain is also maintaining four SSBNs and has just decided to update this force.) The main sign of continuity can be seen in the large frigate category. If one includes in this category the destroyers converted to frigates in the early 1950s and the new Sheffield-class, the force of large frigates built or converted since World War II has remained between 50 and 60 units since 1961. The Leander modernization programs and continuing production of the Sheffield and Broadsword classes will probably keep it there. The 12 second-line frigates of the Dundas class have been disposed of, and, unless some of the new Type-24 export frigates are acquired, they are not likely to be replaced. The shift from diesel to nuclear submarines led to a decline in the attack submarine force from 46 in 1967 to 27 today: construction of a new diesel submarine class, the Type-2400, is now under consideration to prevent further decline. Britain's minesweeper force has declined in size since the mid-1960s along with most other NATO mineforces, but it is now being upgraded qualitatively by production of the Brecon-class minehunters. Britain no longer maintains a force of fast attack craft, and her eight large amphibious ships are used for logistics support or for seamanship training. The

RAF maintains four squadrons of Nimrod maritime patrol craft. Some of these are being converted to airborne early warning aircraft, and the rest are being updated.

At the other end of the Atlantic sea lanes, the Canadian navy has concentrated since the late 1950s almost exclusively on maintaining an effective anti-submarine destroyer and frigate force for service both off her long Atlantic and Pacific coasts. Nearly all other major ship types, including minesweepers, have been disposed of or relegated to subsidiary functions. Between 1955 and 1964 Canada built 20 frigates, which gradually took over from her 32 war-built destroyers and frigates. Of her current inventory of 23 frigates, only the four Iroquois class are fully up to date, and a new patrol frigate, which has now advanced nearly to the contract definition stage, is urgently needed to prevent a decline in the force. Beginning in 1949 Britain loaned Canada three submarines to provide training services for her frigates, and this is now the function of Canada's three Oberon-class submarines. Canada has begun taking delivery of 18 Aurora maritime patrol aircraft (a variant of the U.S. P-3) to replace her Argus fleet.

The French navy differs from the other NATO navies discussed here in two respects. First, France is the only country which is a full member of NATO's civil organization but whose forces are not integrated into NATO's military organization. Second, the French navy is the only one of these navies that still has an important mission outside Europe. Its four missions (which have

changed little since the advent of de Gaulle) are: to participate in nuclear deterrence by maintaining an SSBN force, to maintain surveillance over and, if necessary, to defend the maritime approaches to France in both the Atlantic and the Mediterranean; to retain at sea and overseas the ability to act as necessary to fulfill France's diplomatic obligations and defend her interests; and to carry out public service, or coast guard, tasks.

The French navy's force structure is distinctive in that it is the only European navy to retain an attack carrier force. France has had three to four carriers (including helicopter carriers) since 1953 and will retain the current two attack carriers and one helicopter carrier into the 1990s. Her two attack carriers have just been updated by major overhauls and by procurement of the Super Etendard attack aircraft with a tactical nuclear capability. In the 1990s they will be replaced by two 32,000-ton nuclear-powered carriers. France also has five SSBNs in service and is building a sixth. She has continuously had a handful of cruisers or large missile destroyers to escort the carriers. Her force of destroyers and large frigates remained continuously around 45 units from 1957 to 1974, thanks to a major construction effort in the 1950s, but since then 19 ships have been stricken from the list and only four new ones delivered. The new light frigates of the D'Estienne d'Orves class are taking over the missions of a once numerous class of 450-ton U.S.-type large patrol craft, of which only two survive. France's attack submarine force

has grown steadily from 13 in 1951 to 22 today. A decision has been made that all future French submarines will be nuclear, and, while this will give the French new capabilities, it will also result in reduced submarine force levels. As in other NATO navies, France's minesweeper force increased greatly in the 1950s and has since declined: it is being upgraded qualitatively by the conversion of 10 MSO to minehunters and the construction of 15 new Eridan-class minehunters. Despite the leadership of French industry in the fast attack craft market, the French navy has acquired only a few such ships, and those only for patrol duties. France's nine large amphibious ships are used mainly for logistics duties. The French navy has just begun a program that will replace her Atlantic maritime patrol aircraft with 46 "new-generation Atlantics." France is now completing a six-year naval construction program, and the results of that program and recent French long-range plans will be presented later in this survey.

The Portuguese navy is primarily concerned with the security of three strategically important areas: the Azores, Madeira and Portugal itself. Its colonial mission ended in 1974-75 with the loss of the remaining colonies. Well before that time, however, Portuguese forces began to decline in strength. Until 1969 the combined frigate-destroyer force remained constant at about 13 units, but then it declined rapidly and now consists of seven frigates, completed to 1950s designs between 1966 and 1970. Portugal's force of large patrol craft (PC) and her minesweeping

force (supplied by U.S. and NATO aid) disappeared between 1967 and 1976 except for four minesweepers. In this period of decline the only new construction was 10 light frigates of the Joao Coutinho-class and 10 small patrol craft of the Cacine class. New frigate construction will be necessary if Portugal is to retain a serious anti-submarine capability. Her submarine force has remained constant at around three units.

Spain is not a member of NATO, but coordinates her defenses with some NATO countries by means of bilateral agreements. The primary mission of the Spanish navy is to help maintain sea control in three key areas: the Mediterranean west of the Balearic and Alboran Islands, the Straits of Gibraltar, and the Atlantic between Spain and the Canary Islands. The large number of old ships that were in the Spanish navy in the 1950s have only partially been replaced. In the early 1950s it had six cruisers, 21 destroyers, 18 gunboats and minelayers which served as large frigates, and nine 1400-ton torpedo boats in service or under construction. It now has one light carrier, 13 destroyers, six large frigates and eight light frigates, of which all but five large missile frigates of the Baleares class and three new light frigates of the Descubierta class will have to be retired in the near future due to age. Spain is currently completing five more light frigates of the Descubierta class and plans to build a light carrier and three Peary-class large missile frigates, but these will not compensate numerically for the losses. Spain's submarine

force has remained relatively constant at eight ships, and she currently is building four French Agosta-class ships which will probably replace four World War II U.S. boats. Her force of nine fast attack craft declined to two by 1974, but since then she has built 12 new ones of the Lazaga and Barcelo classes which, however, are used on patrol duties and do not regularly carry missiles or torpedoes. Spain has retained all but one of the 12 MSC she received from the U.S. in the 1950s, and in 1971-72 added four ex-U.S. MSO with some mine locating capability. Since 1976 Spain's carrier has operated seven Harrier V/STOL aircraft (called Matadors) in addition to helicopters. The Spanish Air Force operates six P-3A maritime patrol aircraft.

The Italian navy is responsible for defending Italian trade routes and territory, controlling choke points, and escorting NATO naval forces, all in a vital part of the Mediterranean. The number of large ships that it has maintained to carry out these missions has remained almost constant for the past 30 years; today Italy has three cruisers (which also have helicopter facilities), six destroyers and six large frigates of the Alpino and Cigno classes. In addition, since the early 1960s, she has built eight frigates of the Bergamini and Lupo class that were smaller than most of their foreign contemporaries but had many of the same capabilities. In 1975 a navy law was passed to provide for the updating of this force; the 13,250-ton helicopter carrier Guiseppe Garibaldi was to replace two of the cruisers, two missile destroy-

ers were to replace four units of the Impavido and Indomito classes, and eight Maestrale-class frigates were to replace the eight units of the Cigno and Bergamini classes. The carrier and six of the frigates have been ordered, but funds were not available to begin the other four ships. Two missile destroyers of an improved Audace class with gas turbines are now proposed in the latest budget.

The number of smaller surface combatants in the Italian navy declined sharply in the period. The number of patrol escorts and light frigates has decreased from 34 to eight. A new 1000-ton class is said to be in the planning stage. The number of fast attack craft has also declined sharply, from a peak of 31 to the present five, four of which are old. Six Nibbio-class hydrofoils are now under construction. Italy's mine force has declined from a peak of 60 in the early 1960s to 34 old ones today. Eight of these are being converted to minehunters, and four new minehunters of the Lerici class are under construction. In contrast, the submarine force has increased gradually over the years to the present 10 units. Two additional Sauro-class submarines are building under the navy law to replace some ex-U.S. units. The Italian Air Force has not yet made a decision concerning replacement or updating of its 18 Atlantic maritime patrol aircraft.

The Greek navy has the missions of preserving the territorial integrity of Greece, including all her Aegean Islands, and supporting NATO operations in the critical Southern Flank area.

Since the early 1950s, Greece has consistently had an average of 16 destroyers and large frigates; her current inventory consists entirely of World War II units which, despite being modernized, need replacement. Greece has just purchased one Kortenaer-class frigate in Holland (the sixth in the Dutch series) with options on a second and on a license to build more with Dutch help in Greece. Greece formerly had as many as 15 large patrol craft of various types, but these have disappeared and, since 1967, she has concentrated on building instead a large force of fast attack craft for operations against surface ships. She now has 21 such craft with five more very near completion. Her submarine force declined to two boats in the 1950s, but beginning in 1971 she built it up to its current level of 10 by building eight Type-209 class submarines in Germany. Her mine warfare force has remained constant at 13 to 15 minesweepers and two minelayers. Finally, Greece has constantly maintained a force of eight to ten large landing ships (LST and LSD) which is now one of the largest NATO amphibious forces in Europe.

The Turkish navy has essentially the same missions as the Greek navy and has a very similar force structure, although in the case of Turkey there has been a noticable rise in numbers of ships since the late 1960s. The destroyer and frigate force has grown from 10 in 1951 to 15, although 13 of these are of World War II vintage and will need replacement. The submarine force was built up from its previous level of 10 units to 14 between 1969

and 1973, and has been kept at or above that level by acquisition of Type-209 submarines, which are now being built in Turkey. The modern fast attack force was established in 1964 and now includes 23 units, with four more reported to be on order. The force of wooden minesweepers increased from 11 to 22 units since 1951, offsetting the disappearance of a large number of steel minesweepers. The minelaying force increased from five to nine ships since 1951, although only one of the nine now in service is modern. Finally, Turkey acquired two LSTs in 1973-74 to add to her collection of smaller landing craft, and is now building LSTs and smaller amphibious ships in Turkey.

There is not space to analyze the capabilities of the ships of these 14 navies, but we must take note of the recent proliferation of two types of systems, anti-ship cruise missiles and shipboard ASW helicopters. The former enables many NATO ships to meet their Soviet counterparts on equal terms or better, while the latter gives many of them, including some large coast guard ships, a substantial standoff ASW capability. The spread of area-AAW missile systems has been less spectacular; they are limited to newer cruisers and destroyers, five Spanish frigates, and some Spanish and French frigates just beginning construction.

In some of the non-U.S. NATO navies, current force structures are the result of comprehensive, multi-year new-construction programs sanctioned by the legislature. France is approaching the end of such a program, the Fourth Program Law of 1977-82, and the

1981 budget documents enable us to estimate the success of that program and its impact on the structure of the French navy in 1990. In addition the details of a long-range plan drafted in 1978 have been made public, and as a result we now also know what the French navy thinks (or hopes) its structure will be in the year 2000.

Perhaps the clearest way to estimate the success of the 1977-82 law is to see how many of the ships that were to be delivered during the period were delivered and how many to be ordered were ordered. Based upon 1980 projections, actual deliveries will match planned ones very closely: only three large frigates are to be delivered instead of four planned, but one more light frigate, one more replenishment ship, and two more amphibious ships will be delivered than planned. Orders for new ships also match the program reasonably well, in that ships added to the program since 1976 roughly counterbalance those deleted. Orders were added for one SSBN, two large ASW frigates, three light frigates and one oiler; and orders were deleted or deferred past the program period for one small nuclear V/STOL carrier (PA75), one large AAW frigate, three minehunters and two patrol craft. The deferral of the V/STOL carrier was followed in 1980 by a French decision to build two larger nuclear-powered carriers with conventional aircraft in the late 1980s and 1990s (the first is tentatively scheduled to be ordered in 1983 and the other after 1988). In general the 1977-82

program was successful -- far more so than previous French naval programs.

Table 1 summarizes the actual or expected force structure of the French navy at five points in time: the beginning, the middle, and the end of the 1977-82 program; 1990; and 2000. It should be noted that the figures for 1990 exclude all ships ordered after 1982: this probably affects primarily the mine and patrol craft. The figures for the year 2000 are a "model navy" used for planning purposes; while not derived directly from current forces or programs, they do take into account an estimate of fiscal constraints. Table 1 indicates that in most areas the French expect to be able to maintain their existing force structure to the turn of the century.

Our survey of the 14 navies of Western Europe and NATO indicates that, with some exceptions, they have succeeded in maintaining the numbers of ships in certain key categories at relatively constant levels during the past 30 years and have laid the groundwork for continuing to do so in the 1980s. Particularly impressive is the fact that the 12 non-U.S. NATO navies plus Spain currently have almost 240 destroyers and large frigates, supplemented by over 40 light frigates. They thus have more major surface combatants than does the Soviet navy, though their total tonnage is not as high. The combined force level of destroyers and large frigates has remained surprisingly constant in many of these navies over the last 30 years. The 150 submarine and 170 fast at-

TABLE 1

ACTUAL AND EXPECTED FRENCH NAVAL FORCES, 1976-2000

	31 Dec 76	31 Dec 79	31 Dec 82	1990	2000
Strategic Forces					
SSBN	4	4	5	(6)	(?)
Combatants					
Carriers[1]	3	3	3	3	2
AAW Ships[2]	7	7	6	5	9
ASW Ships[3]	13	13	14	10	18
Avisos and Escorts[4]	27	24	23	20	18
SSN	0	0	0	5	10
SS	21	22	19	6	4
Patrol Craft	30	26	23	9+	10
Mine Craft	29	29	25	20+	40
Auxiliaries					
AO, AR	9	9	9	11	12
Amphibious	9	9	9	11	9

Notes

[1]Includes one helicopter carrier to the mid-1990s.

[2]All cruisers, destroyers, and frigates with area-defense SAM

[3]Destroyers and large frigates beginning with Aconit (1970)

[4]Modern light frigates and large frigates built before Aconit

tack craft in these navies tend to be concentrated on the northern and southern flanks. In general, mine forces were allowed to decline through the 1970s, but major new minehunter programs are now in progress in five countries. One must conclude that these navies have the capability to make a major contribution in the event of a NATO war, as well as supporting their own national objectives.

CNA PROFESSIONAL PAPERS - 1978 TO PRESENT*

PP 211
Mizrahi, Maurice M., "On Approximating the Circular Coverage Function," 14 pp., Feb 1978, AD A054 429

PP 212
Mangel, Marc, "On Singular Characteristic Initial Value Problems with Unique Solution," 20 pp., Jun 1978, AD A058 535

PP 213
Mangel, Marc, "Fluctuations in Systems with Multiple Steady States. Application to Lanchester Equations," 12 pp., Feb 78 (Presented at the First Annual Workshop on the Information Linkage Between Applied Mathematics and Industry, Naval PG School, Feb 23-25, 1978), AD A071 472

PP 214
Weinland, Robert G., "A Somewhat Different View of The Optimal Naval Posture," 37 pp., Jun 1978 (Presented at the 1976 Convention of the American Political Science Association (APSA/IUS Panel on "Changing Strategic Requirements and Military Posture"), Chicago, Ill., September 2, 1976), AD A056 228

PP 215
Colle, Russell C., "Comments on: Principles of Information Retrieval by Manfred Kochen," 10 pp., Mar 78 (Published as a Letter to the Editor, Journal of Documentation, Vol. 31, No. 4, pages 298-301), December 1975), AD A054 426

PP 216
Colle, Russell C., "Lotka's Frequency Distribution of Scientific Productivity," 18 pp., Feb 1978 (Published in the Journal of the American Society for Information Science, Vol. 28, No. 6, pp. 366-370, November 1977), AD A054 425

PP 217
Colle, Russell C., "Bibliometric Studies of Scientific Productivity," 17 pp., Mar 78 (Presented at the Annual meeting of the American Society for Information Science held in San Francisco, California, October 1976), AD A054 442

PP 218 - Classified

PP 219
Huntzinger, R. LaVar, "Market Analysis with Rational Expectations: Theory and Estimation," 60 pp., Apr 78, AD A054 422

PP 220
Maurer, Donald E., "Diagonalization by Group Matrices," 26 pp., Apr 78, AD A054 443

PP 221
Weinland, Robert G., "Superpower Naval Diplomacy in the October 1973 Arab-Israeli War," 76 pp., Jun 1978 (Published in Seapower in the Mediterranean: Political Utility and Military Constraints, The Washington Papers No. 61, Beverly Hills and London: Sage Publications, 1979) AD A055 564

PP 222
Mizrahi, Maurice M., "Correspondence Rules and Path Integrals," 30 pp., Jun 1978 (Invited paper presented at the CNRS meeting on "Mathematical Problems in Feynman's Path Integrals," Marseille, France, May 22-26, 1978) (Published in Springer Verlag Lecture Notes in Physics, 106, (1979), 234-253) AD A055 536

PP 223
Mangel, Marc, "Stochastic Mechanics of Moleculeion Molecule Reactions," 21 pp., Jun 1978, AD A056 227

PP 224
Manger, Marc, "Aggregation, Biturcation, and Extinction in Exploited Animal Populations*," 48 pp., Mar 1978, AD A058 536
*Portions of this work were started at the Institute of Applied Mathematics and Statistics, University of British Columbia, Vancouver, B.C., Canada

PP 225
Mangel, Marc, "Oscillations, Fluctuations, and the Hopf Bifurcation*," 43 pp., Jun 1978, AD A058 537
*Portions of this work were completed at the Institute of Applied Mathematics and Statistics, University of British Columbia, Vancouver, Canada.

PP 226
Ralston, J. M. and J. W. Mann,* "Temperature and Current Dependence of Degradation in Red-Emitting GaP LEDs," 34 pp., Jun 1978 (Published in Journal of Applied Physics, 50, 3630, May 1979) AD A058 538
*Bell Telephone Laboratories, Inc.

PP 227
Mangel, Marc, "Uniform Treatment of Fluctuations at Critical Points," 50 pp., May 1978, AD A058 539

PP 228
Mangel, Marc, "Relaxation at Critical Points: Deterministic and Stochastic Theory," 54 pp., Jun 1978, AD A058 540

PP 229
Mangel, Marc, "Diffusion Theory of Reaction Rates, I: Formulation and Einstein-Smoluchowski Approximation," 50 pp., Jan 1978, AD A058 541

PP 230
Mangel, Marc, "Diffusion Theory of Reaction Rates, II Ornstein-Uhlenbeck Approximation," 34 pp., Feb 1978, AD A058 542

PP 231
Wilson, Desmond P., Jr., "Naval Projection Forces: The Case for a Responsive MAF," Aug 1978, AD A054 543

PP 232
Jacobson, Louis, "Can Policy Changes Be Made Acceptable to Labor?" Aug 1978 (Submitted for publication in Industrial and Labor Relations Review), AD A061 528

*CNA Professional Papers with an AD number may be obtained from the National Technical Information Service, U.S. Department of Commerce, Springfield, Virginia 22151. Other papers are available from the Management Information Office, Center for Naval Analyses, 2000 North Beauregard Street, Alexandria, Virginia 22311. An Index of Selected Publications is also available on request. The Index includes a Listing of Professional Papers; with abstracts; issued from 1969 to June 1981.

PP 233
Jacobson, Louis, "An Alternative Explanation of the Cyclical Pattern of Quits," 23 pp., Sep 1978

PP 234 - Revised
Jondrow, James and Levy, Robert A., "Does Federal Expenditure Displace State and Local Expenditure: The Case of Construction Grants," 25 pp., Oct 1979, AD A061 529

PP 235
Mizrahi, Maurice M., "The Semiclassical Expansion of the Anharmonic-Oscillator Propagator," 41 pp., Oct 1978 (Published in *Journal of Mathematical Physics* 20 (1979) pp. 844-855), AD A061 538

PP 237
Maurer, Donald, "A Matrix Criterion for Normal Integral Bases," 10 pp., Jan 1979 (Published in the Illinois Journal of Mathematics, Vol. 22 (1978), pp. 672-681

PP 238
Utgoff, Kathleen Classen, "Unemployment Insurance and The Employment Rate," 20 pp., Oct 1978 (*Presented at the Conference on Economic Indicators and Performance: The Current Dilemma Facing Government and Business Leaders, presented by Indiana University Graduate School of Business*). AD A061 527

PP 239
Trost, R. P. and Warner, J. T., "The Effects of Military Occupational Training on Civilian Earnings: An Income Selectivity Approach," 38 pp., Nov 1979k, AD A077 831

PP 240
Powers, Bruce, "Goals of the Center for Naval Analyses," *13 pp., Dec 1978, AD A063 759*

PP 241
Mangel, Marc, "Fluctuations at Chemical Instabilities," 24 pp., Dec 1978 (Published in Journal of Chemical Physics, Vol. 69, No. 8, Oct 15, 1978). AD A063 787

PP 242
Simpson, William R., "The Analysis of Dynamically Interactive Systems (Air Combat by the Numbers)," 160 pp., Dec 1978, AD A063 760

PP 243
Simpson, William R., "A Probabilistic Formulation of Murphy Dynamics as Applied to the Analysis of Operational Research Problems," 18 pp., Dec 1978, AD A063 761

PP 244
Sherman, Allan and Horowitz, Stanley A., "Maintenance Costs of Complex Equipment," 20 pp., Dec 1978 (Published By The American Society of Naval Engineers, Naval Engineers Journal, Vol. 91, No. 6, Dec 1979) AD A071 473

PP 245
Simpson, William R., "The Accelerometer Methods of Obtaining Aircraft Performance from Flight Test Data (Dynamic Performance Testing)," 403 pp., Jun 1979, AD A075 226

PP 246
Brechling, Frank, "Layoffs and Unemployment Insurance," 35 pp., Feb 1979 (Presented at the Nber Conference on "Low Income Labor Markets," Chicago, Jun 1978), AD A096 629

PP 248
Thomas, James A., Jr., "The Transport Properties of Dilute Gases in Applied Fields," 183 pp., Mar 1979, AD A096 464

PP 249
Glasser, Kenneth S., "A Secretary Problem with a Random Number of Choices," 23 pp., Mar 1979

PP 250
Mangel, Marc, "Modeling Fluctuations in Macroscopic Systems," 26 pp., Jun 1979

PP 251
Trost, Robert P., "The Estimation and Interpretation of Several Selectivity Models," 37 pp., Jun 1979, AD A075 941

PP 252
Nunn, Walter R., "Position Finding with Prior Knowledge of Covariance Parameters," 5 pp., Jun 1979 (Published in IEEE Transactions on Aerospace & Electronic Systems, Vol. AES-15, No. 3, Mar 1979

PP 253
Glasser, Kenneth S., "The d-Choice Secretary Problem," 32 pp., Jun 1979, AD A075 225

PP 254
Mangel, Marc and Quanbeck, David B., "Integration of a Bivariate Normal Over an Offset Circle," 14 pp., Jun 1979, AD A096 471

PP 255 - Classified, AD B051 441L

PP 256
Maurer, Donald E., "Using Personnel Distribution Models," 27 pp., Feb 1980. AD A082 218

PP 257
Thaler, R., "Discounting and Fiscal Constraints: Why Discounting is Always Right," 10 pp., Aug 1979, AD A075 224

PP 258
Mangel, Marc S. and Thomas, James A., Jr., "Analytical Methods in Search Theory," 86 pp., Nov 1979, AD A077 832

PP 259
Glass, David V.; Hsu, Ih-Ching; Nunn, Walter R., and Perin, David A., "A Class of Commutative Markov Matrices," 17 pp., Nov 1979, AD A077 833

PP 260
Mangel, Marc S. and Cope, Davis K., "Detection Rate and Sweep Width in Visual Search," 14 pp., Nov 1979, AD A077 834

PP 261
Vila, Carlos L.; Zviljac, David J. and Ross, John, "Franck-Condon Theory of Chemical Dynamics. VI. Angular Distributions of Reaction Products," 14 pp., Nov 1979 (Reprinted from Journal Chemical Phys. 70(12), 15 Jun 1979), AD A076 287

PP 262
Petersen, Charles C., "Third World Military Elites in Soviet Perspective," 50 pp., Nov 1979, AD A077 835

PP 263
Robinson, Kathy L., "Using Commercial Tankers and Containerships for Navy Underway Replenishment," 25 pp., Nov 1979, AD A077 836

PP 264
Weinland, Robert G., "The U.S. Navy in the Pacific: Past, Present, and Glimpses of the Future," 31 pp., Nov 1979 (Delivered at the International Symposium on the Sea, sponsored by the International Institute for Strategic Studies, The Brookings Institution and the Yomiuri Shimbun, Tokyo, 16-20 Oct 1978) AD A066 837

PP 265
Weinland, Robert G., "War and Peace in the North: Some Political Implications of the Changing Military Situation in Northern Europe," 18 pp., Nov 1979 (Prepared for presentation to the Conference of the Nordic Balance in Perspective: The Changing Military and Political Situation," Center for Strategic and International Studies, Georgetown University, Jun 15-16, 1978) AD A077 838

PP 266
Utgoff, Kathy Classen, and Brechling, Frank, "Taxes and Inflation," 25 pp., Nov 1979, AD A081 194

PP 267
Trost, Robert P., and Vogel, Robert C., "The Response of State Government Receipts to Economic Fluctuations and the Allocation of Counter-Cyclical Revenue Sharing Grants," 12 pp., Dec 1979 (Reprinted from the Review of Economics and Statistics, Vol. LXI, No. 3, August 1979)

PP 268
Thomason, James S., "Seaport Dependence and Inter-State Cooperation: The Case of Sub-Saharan Africa," 141 pp., Jan 1980, AD A081 193

PP 269
Weiss, Kenneth G., "The Soviet Involvement in the Ogaden War," 42 pp., Jan 1980 (Presented at the Southern Conference on Slavic Studies in October, 1979), AD A082 219

PP 270
Remnek, Richard, "Soviet Policy in the Horn of Africa: The Decision to Intervene," 52 pp., Jan 1980 (To be published in "The Soviet Union in the Third World: Success or Failure," ed. by Robert H. Donaldson, Westview Press, Boulder, Co., Summer 1980), AD A081 195

PP 271
McConnell, James, "Soviet and American Strategic Doctrines: One More Time," 43 pp., Jan 1980, AD A081 192

PP 272
Weiss, Kenneth G., "The Azores in Diplomacy and Strategy, 1940-1945, 46 pp., Mar 1980, AD A085 094

PP 273
Nakada, Michael K., "Labor Supply of Wives with Husbands Employed Either Full Time or Part Time," 39 pp., Mar 1980, AD A082 220

PP 275
Goldberg, Lawrence, "Recruiters Advertising and Navy Enlistments," 34 pp., Mar 1980, AD A082 221

PP 276
Goldberg, Lawrence, "Delaying an Overhaul and Ship's Equipment," 40 pp., May 1980, AD A085 095

PP 277
Mangel, Marc, "Small Fluctuations in Systems with Multiple Limit Cycles," 19 pp., Mar 1980 (Published in SIAM J. Appl. Math., Vol. 38, No. 1, Feb 1980) AD A086 229

PP 278
Mizrahi, Maurice, "A Targeting Problem: Exact vs. Expected-Value Approaches," 23 pp., Apr 1980, AD A085 096

PP 279
Walt, Stephen M., "Causal Inferences and the Use of Force: A Critique of Force Without War," 50 pp., May 1980, AD A085 097

PP 280
Goldberg, Lawrence, "Estimation of the Effects of A Ship's Steaming on the Failure Rate of Its Equipment: An Application of Econometric Analysis," 25 pp., Apr 1980, AD A085 098

PP 281
Mizrahi, Maurice M., "Comment on 'Discretization Problems of Functional Integrals in Phase Space'," 2 pp., May 1980, published in "Physical Review D", Vol. 22 (1980), AD A094 994

PP 283
Dismukes, Bradford, "Expected Demand for the U.S. Navy to Serve as An Instrument of U.S. Foreign Policy: Thinking About Political and Military Environmental Factors." 30 pp., Apr 1980, AD A085 099

PP 284
J. Kellison,* W. Nunn, and U. Sumita,** "The Laguerre Transform," 119 pp., May 1980, AD A085 100
*The Graduate School of Management, University of Rochester and the Center for Naval Analyses
**The Graduate School of Management, University of Rochester

PP 285
Remnek, Richard B., "Superpower Security Interests in the Indian Ocean Area," 26 pp., Jun 1980, AD A087 113

PP 286
Mizrahi, Maurice M., "On the WKB Approximation to the Propagator for Arbitrary Hamiltonians," 25 pp., Aug 1980 (Published in Journal of Math. Phys., 22(1) Jan 1981), AD A091 307

PP 287
Cope, Davis, "Limit Cycle Solutions of Reaction-Diffusion Equations," 35 pp., Jun 1980, AD A087 114

PP 288
Golman, Walter, "Don't Let Your Slides Flip You: A Painless Guide to Visuals That Really Aid," 28 pp., Oct 1980, AD A092 732

PP 289
Robinson, Jack, "Adequate Classification Guidance - A Solution and a Problem," 7 pp., Aug 1980, AD A091 212

PP 290
Watson, Gregory H., "Evaluation of Computer Software in an Operational Environment," 17 pp., Aug 1980, AD A091 213

PP 291
Maddala, G. S.* and Trost, R. P., "Some Extensions of the Nerlove Press Model," 17 pp., Oct 1980, AD A091 946
*University of Florida

PP 292
Thomas, James A., Jr., "The Transport Properties of Binary Gas Mixtures in Applied Magnetic Fields," 10 pp., Sept 1980 (Published in Journal of Chemical Physics 72(10), 15 May 1980

PP 293
Thames, James A., Jr., "Evaluation of Kinetic Theory Collision Integrals Using the Generalized Phase Shift Approach," 12 pp., Sept 1980 (Printed in Journal of Chemical Physics 72(10), 15 May 1980

PP 294
Roberts, Stephen S., "French Naval Policy Outside of Europe," 30 pp., Sept 1980 (Presented at the Conference of the Section on Military Studies, International Studies Association Kiawah Island, S.C.), AD A091 306

PP 295
Roberts, Stephen S., "An Indicator of Informal Empire: Patterns of U.S. Navy Cruising on Overseas Stations, 1869-1897," 40 pp., Sept 1980 (Presented at Fourth Naval History Symposium, US Naval Academy, 26 October 1979, AD A091 316

PP 296
Dismukes, Bradford and Petersen, Charles C., "Maritime Factors Affecting Iberian Security," (Factores Maritimos Que Afectan La Seguridad Ibelca) 14 pp., Oct 1980, AD A092 733

PP 297 - Classified

PP 298
Mizrahi, Maurice M., "A Markov Approach to Large Missile Attacks," 31 pp., Jan 1981, AD A096,159

PP 299
Jondrow, James M. and Levy, Robert A., "Wage Leadership in Construction, 19 pp , Jan 1981, AD A094 797

PP 300
Jondrow, James and Schmidt, Peter,* "On the Estimation of Technical Inefficiency in the Stochastic Frontier Production Function Model," 11 pp., Jan 1981, AD A096 159
*Michigan State University

PP 301
Jondrow, James M.; Levy, Robert A. and Hughes, Claire, "Technical Change and Employment in Steel, Autos, Aluminum, and Iron Ore, 17 pp., Mar 1981, AD A099 394

PP 302
Jondrow, James M. and Levy, Robert A., "The Effect of Imports on Employment Under Rational Expectations," 19 pp., Apr 1981, AD A099 392

PP 303
Thomason, James, "The Rarest Commodity in the Coming Resource Wars," 3 pp., Aug 1981 (Published in the Washington Star, April 13, 1981)

PP 304
Duffy, Michael K.; Greenwood, Michael J.* and McDowell, John M.,** "A Cross-Sectional Model of Annual Interregional Migration and Employment Growth: Intertemporal Evidence of Structural Change, 1958-1975," 31 pp., Apr 1981, AD A099 393
*University of Colorado
**Arizona State University

PP 305
Nunn, Lewis H., "An Introduction to the Literature of Search Theory," 32 pp., Jun 1981

PP 306
Anger, Thomas E., "What Good Are Warfare Models?" 7 pp., May 1981

PP 307
Thomason, James, "Dependence, Risk, and Vulnerability," 43 pp., Jun 1981

PP 308
Mizrahi, M.M., "Correspondence Rules and Path Integrals," Jul 1981. Published in "Nuovo Cimento B", Vol. 61 (1981)

PP 309
Weinland, Robert G., "An (The?) Explanation of the Soviet Invasion of Afghanistan," 44 pp., May 1981

PP 310
Stanford, Janette M. and Tai Te Wu,* "A Predictive Method for Determining Possible Three-dimensional Foldings of Immunoglobulin Backbones Around Antibody Combining Sites," 19 pp., Jun 1981 (Published in J. theor. Biol. (1981) 88, 421-439
*Northwestern University, Evanston, IL

PP 311
Bowes, Marianne, Brechling, Frank P. R., and Utgoff, Kathleen P. Classen, "An Evaluation of UI Funds," 13 pp., May 1981 (Published in National Commission on Unemployment Compensation's Unemployment Compensation: Studies and Research, Volume 2, July 1980)

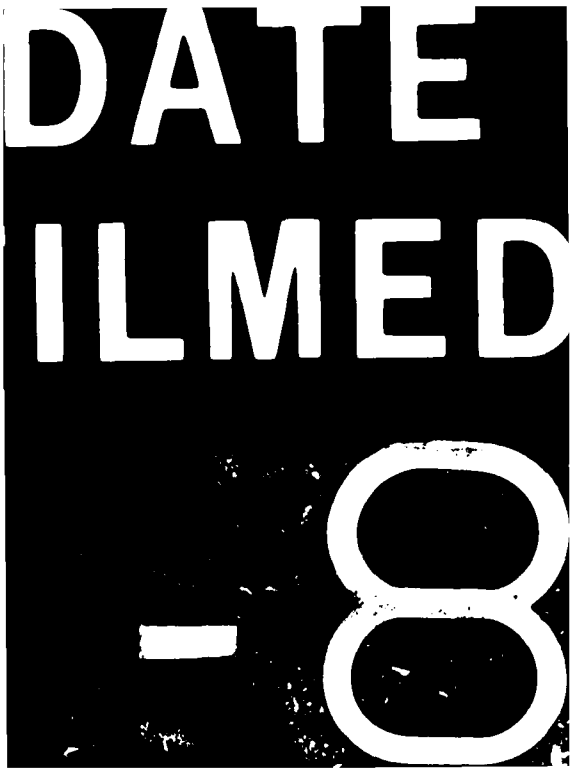
PP 312
Jondrow, James; Bowes, Marianne and Levy, Robert, "The Optimum Speed Limit," 23 pp., May 1981

PP 313
Roberts, Stephen S., "The U.S. Navy in the 1980s," 36 pp., Jul 1981

PP 315
Buck, Ralph V., Capt., "La Catastrophe by any other name...," Jul 1981

PP 316
Roberts, Stephen S., "Western European and NATO Navies, 1980," 20 pp., Aug 1981

PP 317
Roberts, Stephen S., "Superpower Naval Crisis Management in the Mediterranean," 35 pp., Aug 1981


DATE
ILMED
-8